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DVD For Space Archives

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One of the federal government's largest digital archives resides in the Data Distribution Laboratory at NASA's Jet Propulsion Laboratory in Pasadena, Calif.

The vast collection of data created as a result of the numerous exploratory spacecraft launched by NASA over the years constitutes one of the most valuable data collections ever created. The DDL, in partnership with NASA's Planetary Data System, is charged with the safekeeping of these priceless data in a manner that is both cost-effective and accessible to the public (who, after all, paid for the data's collection).

In light of this, NASA engineers and scientists have looked to CD-ROM and CD-R optical storage to preserve these data because it provides a very low cost per megabyte, and perhaps more important, because it conforms to international physical and logical standards. Indeed, the DDL staff has been very active over the years in the development of standards for CD-ROM and CD-R.

It was natural, then, that NASA would pursue the next generation of CD technology, DVD, as a means of continuing to improve the cost-effectiveness of their archiving activities. In fact, this is what happened, as NASA is one of the first agencies to embrace the technology of DVD-R.

The DDL began its evaluation of DVD-R technology in early 1998. The strategy was to obtain a DVD recorder for preliminary testing, deploy reader hardware to user sites for compatibility testing, and develop proof-of-concept archive collections to test the reliability and usability of DVD-R media and jukebox hardware.

The deployment of readers was delayed until the fall of 1998, when the first DVD-ROM readers with SCSI interface became available. This was critical because much of the NASA science community uses Unix workstations with standard interfaces for SCSI peripherals.

About a dozen readers were purchased and deployed to six geographically distributed sites that make up NASA's Planetary Data System. As with most new technologies, users were forced to upgrade their operating systems to the very latest versions to support the new Universal Data Format -- ISO 9660 Bridge logical format standard, which is used on DVDs. To provide a large local DVD storage capacity, the DDL purchased a Pioneer DRM-1004V40 DVD jukebox with a storage capacity of 470 gigabytes and also upgraded a Pioneer DRM-5004X CD-ROM jukebox with four DVD readers, increasing its storage capacity to more than 2 terabytes.

In order to evaluate DVD-R media for archival applications, it was decided to develop two proof-of-concept test cases. The first was a 400-GB database of star images collected by the Near-Earth Asteroid Tracking program. This program has collected thousands of images in visible wavelength with substantial sky coverage and temporal sampling of minutes, days,

months and years in a search for near-Earth objects. The main project deliverable is the asteroid database that is generated from sophisticated computer processing and a set of 8-millimeter tapes containing the image collection.

A JPL scientist, Dr. Steven H. Pravdo, realized the long-term potential of the image collection for supporting other types of astronomical research and petitioned NASA for funds to produce a DVD archive of the image collection.

The production process involved electronic transfer of 36 GB at a time from the processing facility to the DDL; partitioning of the 36 GB into nine DVD volumes with a Java utility called DVD-Partition; pre-mastering the resulting volumes and recording the nine DVD-R discs. Each step of this process was very *non*-labor-intensive, requiring only a minute or two of operator setup time. The complete SkyMorph archive of 115 discs was produced in about six weeks and required less than 40 hours of labor.

The second test case was the production of an DVD-R copy of the 850 CD-ROM discs generated by the Planetary Data System over the past 15 years.

This collection represents the vast majority of images and other scientific data sets resulting from NASA space exploration. While many of these volumes have been accessible at various Web sites around the country, this task allowed the entire collection to be available online for the first time. It has opened up new possibilities for advanced access capabilities and data mining. The processing was similar to the SkyMorph system, except that the volumes were staged from a CD jukebox. The conversion took about 10 weeks to complete.

We are currently developing a DVD production system that will utilize the Pioneer DRM-7000 jukebox with an internal recorder to completely automate the production and replication of hundreds of DVD-R discs from data produced by the Near Earth Asteroid Rendezvous mission and the Mars Global Surveyor project. We are also in the process of acquiring an MPEG-2 encoding capability and DVD-Video production software to begin creating a library of technical and educational presentations for distribution via DVD-R or network server.

Overall, we are very happy with the quality of the DVD-R discs, though we do not have the equipment to do rigorous testing. Our attempts to do longevity testing with the National Media Lab have been unsuccessful because we do not have the right models to use for life-expectancy tests. We have encountered one troublesome incompatibility between discs and readers, involving the Toshiba DVD reader.

The biggest problem with DVD-R technology is that it isn't happening fast enough. There is still no competition for recorders, so the price remains extremely high. The 4.7-GB media is a fairly immature product, and prices are about four times higher for the same storage capacity as CD-R media. Making the whole situation more difficult, hardware vendors continue to sell computer systems without DVD support built-in.

The incredible potential for informational, educational and entertainment products will not be realized until DVD readers are standard equipment on every computer that is sold.

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